

Rocky Mountain Research Station Science You Can Use **Bulletin**



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Winter Sports and Wildlife: Can Canada lynx and winter recreation share the same slope?

When enjoying a beautiful day out snowmobiling or skiing in the backcountry of the Rocky Mountains, you're probably not spending a lot of time wondering if you are chasing the wildlife out of the area. But, based on what we know about recreation impacts, many wildlife species respond negatively to winter recreation. Human use of winter backcountry is on the

rise in Colorado and all over the western United States, owing to both population increases and technological advancements in motorized and non-motorized recreation equipment. Consequently, it is important to know at what point recreational use of an area makes it unusable for wildlife, and sensitive wildlife species, in particular.

One sensitive species that uses the same general montane areas as winter recreators is the elusive Canada lynx. These animals are a Threatened species in the continental United States and are of concern to managers because they rely on deep snow for hunting success during winter, and this snow condition can be affected by changes in forest condition and climate change.



To study their movements, eighteen adult lynx were trapped and radio-collared in two study areas (the San Juans and Vail Pass), and a total of around 64,000 GPS locations were logged between January and March for 3 years to determine how the lynx were moving and where they were spending their time compared to people recreating. Photo by S. Sunday.

It's unclear exactly how widespread lynx were in the contiguous United States historically; we think they were mostly found near the Canadian border in Washington, Montana, Minnesota, and Maine, and also in the Greater Yellowstone Region. Having been extirpated from Colorado (or at least greatly reduced in numbers) by the 1970s, 218 of these animals were reintroduced to the San Juan Mountains in Colorado between 1999 and 2006. Since then, they have also established in the White River National Forest area, home of Vail Ski Resort and some of the most intensely used backcountry winter recreation areas in Colorado.

SUMMARY

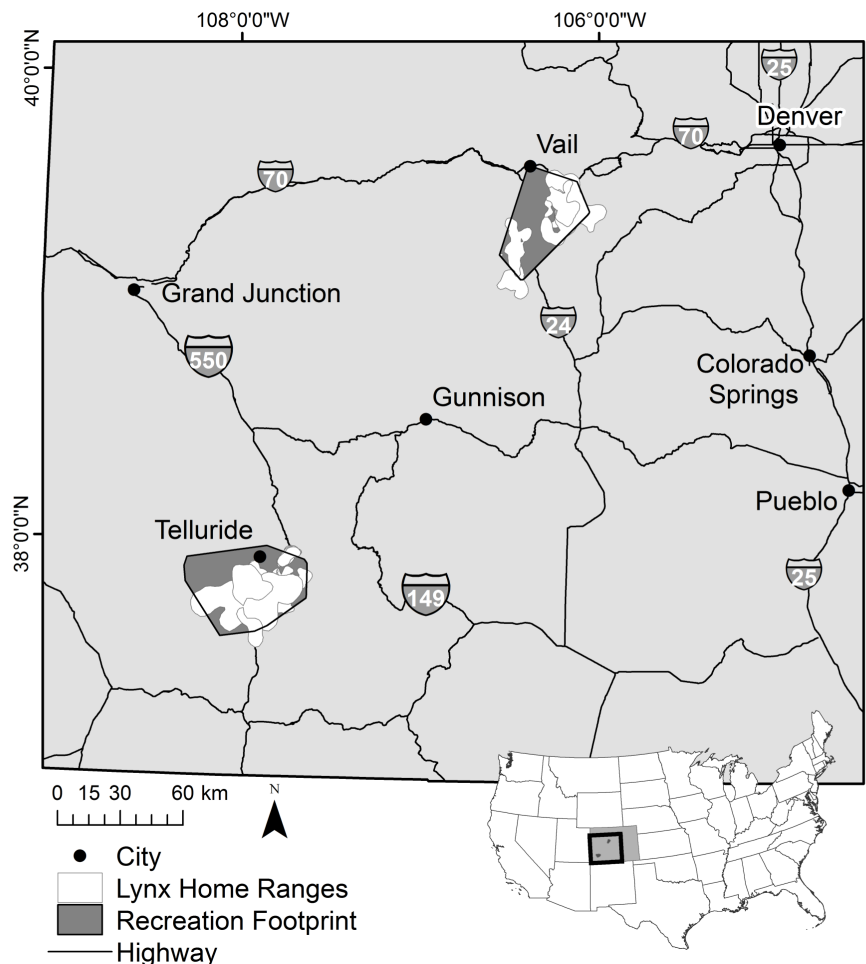
Winter recreation is a popular outdoor activity that is expected to increase in intensity due to new recreation technology and human population growth in the United States. RMRS researchers and partners studied impacts of dispersed (skiing and snowmobiling) and developed (ski areas) winter recreation on Canada lynx in Colorado. They used data from GPS devices carried by recreators to record their tracks and GPS collars to monitor movements of adult lynx to see how they overlapped. They didn't find any consistent evidence that lynx avoided areas of low to moderate dispersed recreation. Lynx avoided some areas with high levels of motorized recreation, but regularly used areas near busy, back-country ski trails. However, they did find that lynx modified their behavior in some cases; they slowed their movement or increased time spent stationary in areas with high-intensity back-country skiing and snowmobiling. They also became more active at night in areas with high-intensity recreation. Also, importantly, environmental features such as high forest canopy cover generally separated areas selected by lynx from those selected by winter recreationists. Lynx appeared to avoid high-intensity developed ski resorts during periods of high-intensity winter recreation. It appears that lynx, at least in these study areas, do not exhibit strong avoidance patterns to dispersed recreation, but instead modified their behavior, perhaps to lower the chance of contact with recreationists and they used dense forests that were less selected by winter recreationists. Based on avoidance of the intense level of recreation found at a developed ski resort, it appears that there is a threshold of human disturbance above which lynx cannot coexist with winter recreation.

Now, forest and recreation managers and wildlife biologists need to know if lynx can co-exist with people recreating in and around their habitat, and whether this might cause lynx to change how they move through the landscape. These questions were addressed by wildlife researchers Lucretia Olson and John Squires from the Rocky Mountain Research Station in Missoula, Montana—along with their partners at USFS, Colorado Parks and Wildlife, and University

of Montana—who used novel methods to track the paths and use patterns of lynx as well as people snowmobiling and skiing in the backcountry to get an answer.

Ski tracks in the snow— Getting a handle on human movement in the backcountry

The need for figuring out how people were using the backcountry and how it might overlap with lynx habitat use grew out of the success of the lynx



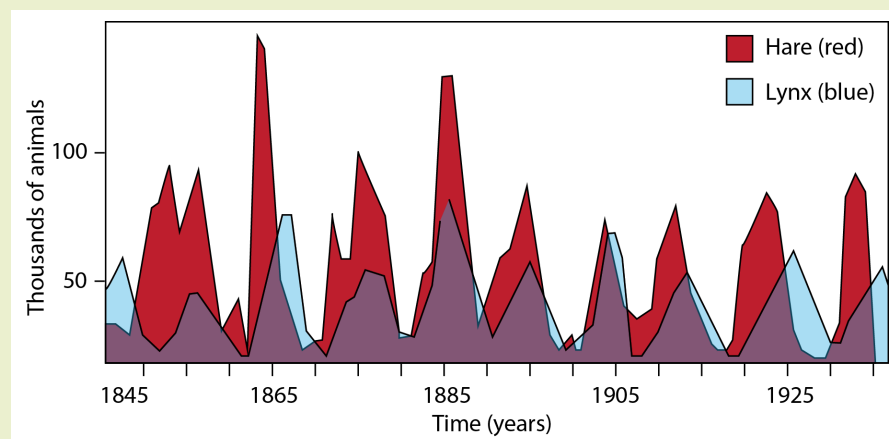
The two areas where lynx and recreation were studied included part of the San Juan range in Colorado (near Telluride) and the part of the White River National Forest (near Vail). Canada lynx home ranges are shown in white, and the recreation areas studied are shown in dark gray. Graphic by L. Olson.

LYNX IN COLORADO—How Are They Faring After Reintroduction?

Every ecology student is shown a classic graph with an alternating boom-bust cycle of snowshoe hares and lynx. The story goes that when the lynx are doing well, they drive the hare population down, and then their own population decrease follows due to lack of food, allowing the snowshoe hares to rebound, and so on. According to Jake Ivan, a wildlife researcher at the Colorado Department of Parks and Wildlife, trapping records indicate lynx were found in Colorado in the past, but it is unclear whether they were part of a permanent resident population. He explains, “It is possible that lynx had been in Colorado for centuries, or that the only reason we had lynx in the State is that every 10 years when the hares crashed in Canada, we would get an influx of lynx from the north, but that there weren’t enough hares in the habitat here to really sustain them otherwise. Or some combination of both.”

The last confirmed record of lynx in Colorado was in late 1974 near Vail, and it was listed as State endangered right around that time, according to Ivan. “We had no other confirmed sightings of lynx since then. We completed several Statewide surveys and snow tracking surveys between ‘74 and the mid-nineties, and a small handful of those turned up things that might have been lynx. By the mid-nineties we thought lynx were either extirpated from the State or so few in numbers that they were functionally gone. And we also thought, in modern America, that the chances of more lynx coming from Canada or Montana and making it all the way to Colorado is probably not great.” And so, the decision was made by Colorado Parks and Wildlife (then the Colorado Division of Wildlife) to relocate around 200 animals from Canada and Alaska to the San Juan mountain area of Colorado between 1999 and 2006.

By 2010, all indications were that the vast majority of animals relocated there had stayed in the State and they seemed to be surviving and reproducing well enough that the population was on a slight upward trajectory. Since then, Colorado Parks and Wildlife has tried to gauge the long-term success of the reintroduction. According to Ivan, “It takes a lot of money, and people power, and effort to catch and put collars on lynx. So, we’re trying to figure out some ways where we can monitor the population in the State in a much more efficient, cost-effective manner. Now, we’re using game cameras and snow tracking to keep tabs on the lynx population in the State. We plan to do that for at least another decade.”



Canada lynx and snowshoe hare populations were estimated each year for 75 years from fur trapping records kept by Hudson Bay Company in Canada. Because lynx are so dependent on snowshoe hares as their main prey species, there is a clear relationship between the population numbers of the two species. Graphic by Lumen Learning.

reintroduction program. After being initially relocated to the San Juan mountains, lynx spread into the White River area of Colorado, where there are 11 developed ski areas and some areas of very intense dispersed recreation (like snowmobiling and backcountry skiing). According to Elizabeth Roberts, who at the time was the winter sports wildlife biologist for the White River National Forest, “I had quite a few proposed management projects that were difficult to evaluate the impacts of without the science, whether it was a ski area expansion or increased amount of recreation in a particular area. We had some cameras installed and we were finding lynx on the White River. But the important question was how much recreation can lynx tolerate? That we didn’t know the answer to.”

The first step to understanding the compatibility of lynx and winter recreation is to get some idea of the intensity of the recreational use of lynx habitat by people. “For example,” says Roberts, “Vail Pass Winter Recreation Area [in the White River National Forest] is about 50,000 acres, and we have that designated for winter recreational use in most of the area. But what we didn’t know is, do people really use all of that area?”

There are a few ways to get a general idea, like using trail counters to quantify daily traffic. But getting a precise handle



A backcountry skier carries a GPS unit as part of this study, which will track the path he takes through the slopes. The paths of skiers and snowmobilers were recorded when they voluntarily carried and returned GPS units, and were compared with the recorded positions of lynx to determine if lynx were avoiding recreators. Photo by Round River Conservation Studies.

on where people are travelling through potential lynx habitat requires that they personally carry GPS units while recreating. But would they? According to the lead scientist on this project, John Squires, “An old warden stood up at our first meeting and said, ‘These recreationists aren’t going to cooperate with you. They’re not going to carry anything, especially those motorized recreationists.’ “

Undaunted, the research team moved ahead with their plans to ask recreators to carry and return GPS units, and luckily for them the warden was wrong. “Almost everyone cooperated with us,” recalled Squires. “We

think that part of the reason was, we hired backcountry outdoor-recreation-type technicians that could talk their talk. They would approach a vehicle and say, ‘Hey, we’re doing a lynx study. We’re not keeping personal information, but we’d like to just document how people move through this area compared to lynx.’ About 90 percent of the people we approached—both backcountry skiers and motorized recreators—were happy to help by carrying GPS units for the day.” Drop boxes were set up at trailheads and in nearby towns to help collect the GPS units, and the researchers offered to provide the GPS information to the recreationists

to view in Google Earth so that they could see their tracks. This phase of the study, according to Squires, logged over 2,000 unique recreation tracks in both the San Juan Mountains and Vail Pass area to provide a detailed spatial estimate of recreation intensity and is one of the largest depictions to date of how humans involved in winter recreation move through the landscape.

And what did the GPS data show? The researchers recorded differences in where you find people on snowmobiles vs backcountry skis based on the environmental characteristics that are more ideal for each sport. That is, while both sports require reasonable proximity to highways, some open forest roads for access, and most importantly, snow, snowmobiling tended to occur further from highways, where there were higher densities of forest roads and more open, smooth, gentle slopes and valley bottoms. Backcountry skiing, on the other hand, happened closer to highways, in areas with fewer roads, more tree cover, and steeper terrain and ridges.

Paw prints in the snow—Do lynx avoid backcountry skiers and snowmobilers?

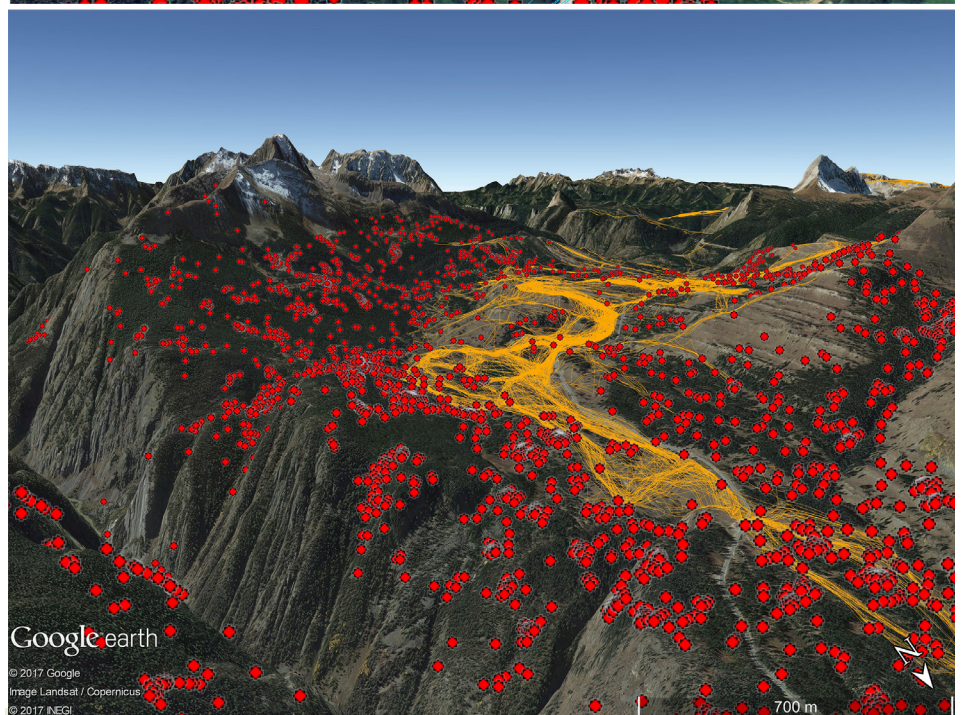
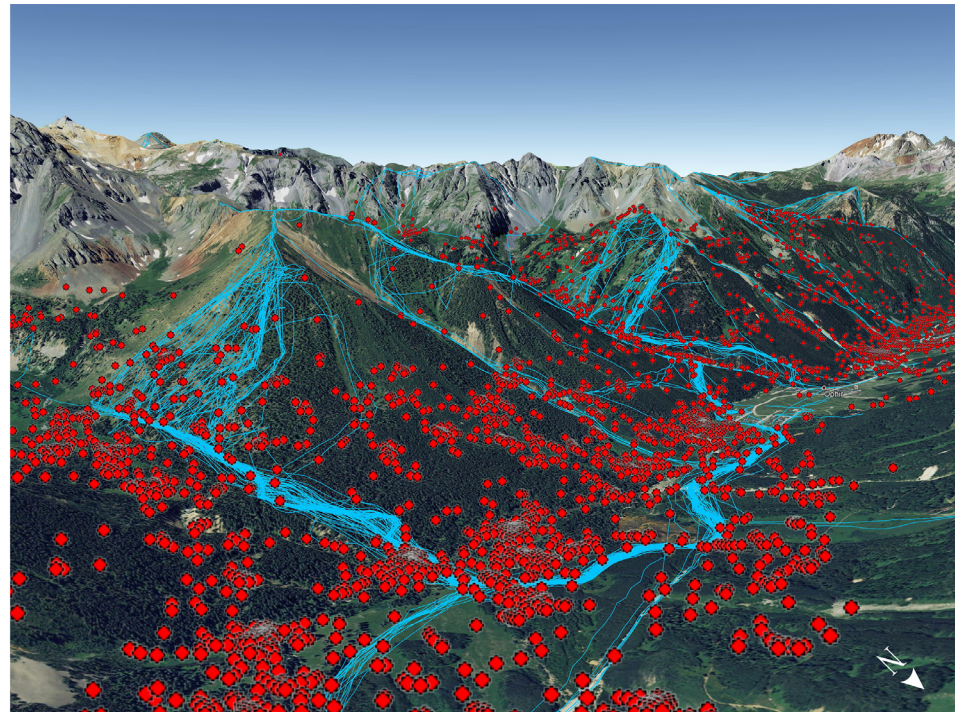
With information on how winter recreationists move through the landscape, the team then asked, how much overlap is there between lynx and people on

the slopes? Do lynx avoid areas where people are recreating?

In the winter, lynx are highly dependent on availability of one particular food source. “Their whole life revolves around the abundance and vulnerability of snowshoe hares,” says Squires, “and snowshoe hares, in turn, are very dependent on the amount of horizontal cover in a forest, because everything—from a goshawk, to an owl, to lynx—likes to eat them.” Horizontal cover in a coniferous forest can be envisioned as the number of tree boughs that are touching the snow surface, simultaneously providing a place for the hares to hide from the myriad of predators as well as conifer needles to eat and sustain them through winter. And where you have this protective winter cover in lynx country, you’ll find lynx hunting hares.

To study their movements, eighteen adult lynx were trapped

They found that the potential for conflict between lynx and recreationists was lessened by the fact that the lynx, skiers, and snowmobilers divide up the slopes in different ways largely related to the density of forest cover.



These figures show the paths taken by backcountry skiers in the San Juan study area, near Ophir, Colorado (blue, top panel) and snowmobilers near Molas Pass, Colorado (orange, bottom panel) recreating in a landscape used by Canada lynx (red dots) in 2012–2013. Backcountry skiers and lynx tend to show more habitat overlap, since both select areas with greater forest canopy cover, compared to snowmobilers that selected more open areas. Graphics by L. Olson.

KEY FINDINGS

- The GPS tracking data showed that snowmobilers on trails prefer shallow slopes, valley bottoms, and lower canopy cover, while skiers prefer greater canopy cover, steep slopes, and ridges. All types of recreation, however, were driven by presence of snow and access.
- Lynx have different habitat preferences than snowmobilers and so may be unlikely to frequently come into contact with them. Lynx and skiers, however, both prefer steeper slopes, dense canopy, and patchy forest cover.
- Lynx do not appear to be as sensitive to low and moderate levels of skiing and snowmobiling as originally thought; instead, lynx modify their behavior to avoid some types of recreation, but appear to be fairly tolerant of non-motorized (skiing) types of recreation.
- High intensities of winter recreation, such as at developed ski areas, may represent a threshold above which lynx have a difficult time coexisting.

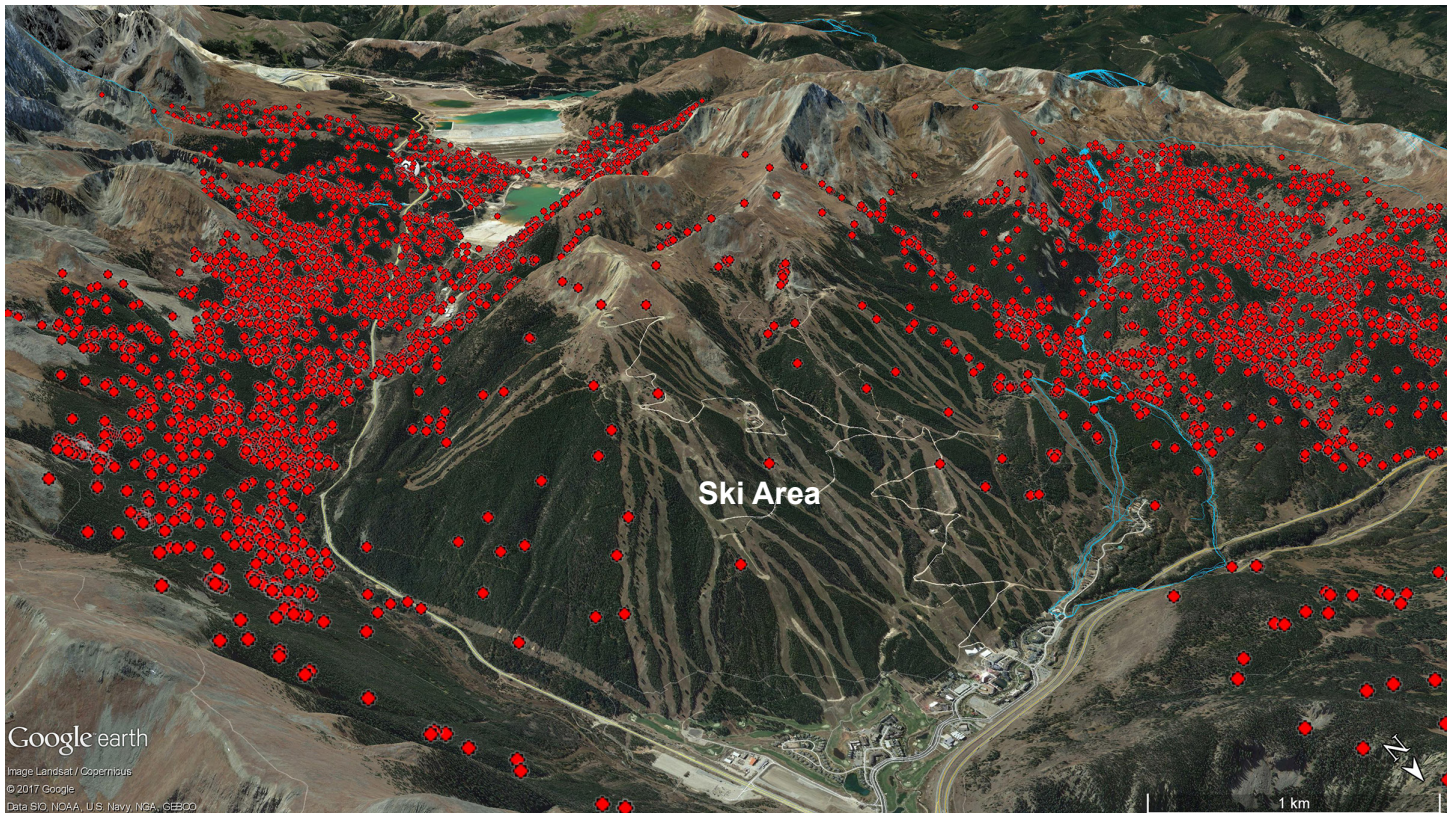
and radio-collared in the same two study areas (the San Juan Mountains and Vail Pass) as the recreationists, and a total of around 64,000 GPS locations were logged between January and March during 3 years to determine how the lynx were moving and where they were spending their time compared to people recreating. “We started the project with the expectation that lynx would be bothered by recreation,” recalls Olson, “because the general response to recreation is negative in most other wildlife studies.”

They found that the potential for conflict between lynx and recreationists was lessened by the fact that the lynx, skiers, and snowmobilers divide up the slopes in different ways largely related to the density of forest cover. The use by lynx of areas with dense horizontal forest cover for hunting hares serves to segregate them to some extent

from skiers and snowmobilers. Snowmobilers, in particular, are using more open slopes. “We thought snowmobiling might be a big concern, but it seems like lynx aren’t going to be in the areas that they normally use,” explains Olson. Lynx and skiers, however, appear to share a similar preference for steeper slopes, dense canopy, and patchy forest. Contrary to expectations, however, the researchers found no consistent avoidance of low-to moderate-intensity levels of snowmobiling, back country skiing, or packed trail skiing. Lynx exhibited some avoidance of areas with higher levels of motorized recreation and developed ski areas, but not to high-use, backcountry ski trails. “They get a lot of skier traffic on Vail Pass, like the 10th Mountain Division trails that go up to the huts. And there’s no evidence of any avoidance of the immediate trail buffer by lynx,” explains Squires, “They use the area right

“Despite our study areas including some of the highest levels of winter recreation in North America, Canada lynx and winter recreationists selected different environmental features across landscape that resulted in low overlap with snowmobiling and moderate overlap with backcountry skiing.”

next to the trail, and they cross the trail, they’re all over the trail. However, despite our study areas including some of the highest levels of winter recreation in North America, Canada lynx and winter recreationists selected different environmental features across landscape that resulted in low overlap with snowmobiling and moderate overlap with backcountry skiing. For example, lynx inhabited forest with higher levels of forest canopy cover than typically used by recreationists. Lynx also modified their behavior in nuanced ways by decreasing their movement rate or increasing time spent not moving, or becoming more active at night, in areas with more high-intensity dispersed recreation.”



This figure shows the distribution of Canada lynx (as red GPS points) around a ski resort in western Colorado, USA. The lynx locations indicate avoidance of this heavily used area. Individual ski runs are the light-colored lines in the center of the picture, while the resort infrastructure is toward the bottom right. Lower intensity dispersed skiing (blue lines) along a groomed trail to a back-country hut is shown to the right of the ski area; lynx did not avoid this type of use. Graphic by L. Olson.

How much recreation is too much?

What happens when the level of recreation reaches the intensity of a developed downhill ski area like Copper Mountain, Vail, or Telluride? Though the study was limited in the number of lynx the researchers were able to collar near ski resorts, they found that lynx generally avoided going inside a ski area boundary, especially during busy times such as daytime and weekends. “Basically”, says Olson, “we found that lynx tended to avoid really high intensity recreation, like what was found specifically

around the ski areas.” So, even though lynx didn’t avoid a low-to-moderate level of dispersed recreation in these studies, there is likely a recreation threshold between that and the high intensity of use at a developed ski area at which an area is no longer usable to lynx.

Some further considerations for lynx and recreation...

This study has implications for managing winter recreation while protecting lynx habitat and also raises some questions. According to Roberts, “I think lynx and recreation can coexist

in the landscape. But because we see a threshold where they avoid the developed ski areas, we need to ask, if we want to expand a ski area, and it happened to be primary lynx habitat, how does that affect the rest of the area? We know that developed areas

There is likely a recreation threshold between that and the high intensity of use at a developed ski area at which an area is no longer usable to lynx.

with very high use may displace lynx from habitat.”

The presence of lynx documented in this study confirms the importance of the habitat in the White River Forest to lynx in Colorado. Roberts explains, “The Vail Pass area is an important place for movement corridors; it’s a very busy place, and the managers really understand the need to provide for connectivity in these critical areas that we’ve identified.”

Another unknown is the effect of climate change on lynx, and how recreation factors into the equation. The direction of the change in terms of intensity of recreation is hard to predict. On one hand, a shorter season and reduced area of snow could concentrate recreation and increase the intensity. On the other hand, as Squires points out, “People may say ‘Okay, the recreation season’s too short, I’m not going to buy a \$10,000 snowmobile, I’ll buy a boat instead.’ And in that case, winter motorized recreation declines. So, I don’t know, but I think it’s

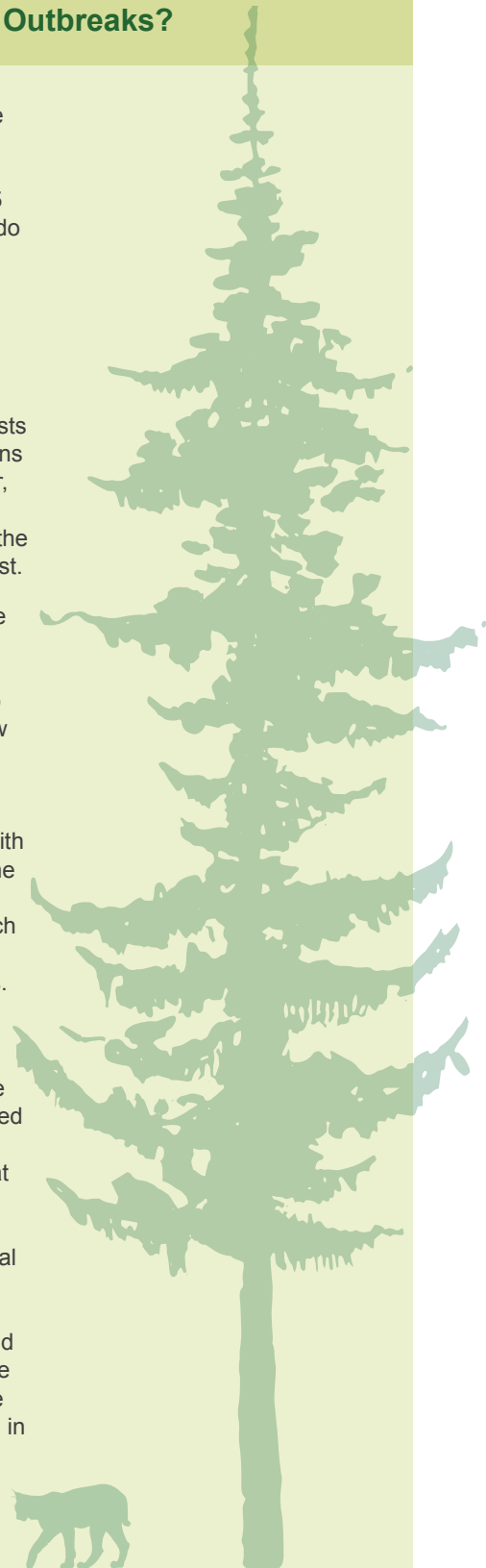
“Now, is recreation a bigger threat to lynx than altered natural disturbance patterns like fire and beetles as increased by climate change? No. Not even close.”

GOING A LITTLE DEEPER: How Will Canada Lynx Respond To Spruce Bark-Beetle Outbreaks?

The Rio Grande National Forest, located in the San Juan Mountains of southern Colorado, includes some of the most important habitat for Canada lynx in Colorado. Approximately 85 percent of the 218 lynx reintroduced to Colorado from 1999–2006 were released on the Rio Grande Forest. Although Canada lynx have established home ranges in other parts of the State, most lynx remain and reproduce in the high-elevation spruce-fir zone of southwestern Colorado. Canada lynx have evolved to live in deep snow and they depend on spruce-fir forests with dense understories that support populations of snowshoe hare, their primary prey. However, by 2013, a spruce beetle outbreak killed approximately 85 percent of mature spruce in the subalpine cover types on the Rio Grande Forest.

The U.S. Forest Service is considering salvage of beetle-killed trees across areas of southern Colorado but there are questions about how to accomplish timber salvage in ways that also encourage persistent lynx populations and how Canada lynx used spruce-fir forests after a spruce-beetle outbreak. The Rocky Mountain Research Station’s Wildlife and Terrestrial Ecosystems Program (WTE), in cooperation with the Rio Grande National Forest, Region 2 of the Forest Service, Colorado Parks and Wildlife, and Montana State University, initiated research to discover patterns of resource selection for Canada lynx in spruce-beetle impacted forests.

Preliminary results suggest that despite large-scale change from beetle impacts, lynx still occupy these forest. Statistical models indicate that we can predict where in the beetle-impacted forests of the Rio Grande National Forest are most likely to support lynx. In addition, lynx that occupy beetle-impacted forests are especially dependent on live forests that remain in the sub-canopy; this information informs silvicultural plans when salvaging beetle-impacted forests used by lynx. This research aims to provide insights related to balancing timber salvage and management across broad landscapes with the conservation needs of Canada lynx, an elusive resident of the deep-snow environments found in the Colorado high-country.



safe to say, that there will be some impact by climate change on recreation, and it's difficult to predict." He adds, "Now, is recreation a bigger threat to lynx than altered natural disturbance patterns like fire and beetles as increased by climate change? No. Not even close."

There are still some questions that will require further research to answer. "We don't know how recreation is affecting the demography of the lynx—their ability to produce kittens and raise them successfully. We have some anecdotal evidence that

the lynx are denning in these landscapes where people are recreating. But at this point we don't have enough data to allow us to make determinations about that," says Squires.

Since the reintroduction of lynx to Colorado, scientists at Colorado Parks and Wildlife (CPW) tracking this effort believe that animals are successfully reproducing and that the population is holding steady [see box on page 3], according to Jake Ivan, a CPW wildlife researchers. The results of the CPW monitoring program,

and research partnerships between USFS researchers and the CPW like the recreation study described in this article, will allow managers to make informed decisions on how maintaining current levels of recreation and expansion of existing recreation areas might affect this species in the future. Roberts points out, "For my recreation managers here on the White River, I think there were questions they were asking that I couldn't give them answers to. Now, I feel like we have a better idea of the overlap that exists between lynx and people."



Captured lynx were fitted with radio collars, which allowed researchers to follow their movements and plot locations relative to snowmobilers, backcountry skiers, and resort skiers. Photo courtesy of the Rocky Mountain Research Station, Northern Rockies Lynx Study.

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Photo by the Rocky Mountain Research Station, Northern Rockies Lynx Study (Ted Wood).

MANAGEMENT IMPLICATIONS

- Tracking people involved in winter recreation gives important insight into where certain activities may be concentrated, and where the greatest potential is for conflict between motorized and non-motorized types of recreation and people and wildlife.
- Lower levels of dispersed recreation at the intensities seen at these Colorado study areas appears to be compatible with lynx occurrence.
- Lynx appear to have an upper threshold of recreation intensity which they can tolerate, and above this level, lynx may be less able to coexist. Managers, then, should keep in mind that developed or dispersed areas with very high use may displace lynx from habitat.
- Lynx select dense forests with high canopy cover during winter. Forest management that alters tree density could alter how lynx and winter recreationists partition landscapes.
- It is still unclear how recreation affects other aspects of lynx biology, such as ability to successfully den and raise kittens, and this is an area that requires further research.

FURTHER READING

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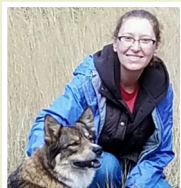
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SCIENTIST PROFILES

The following scientists were instrumental in the creation of this Bulletin:



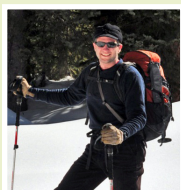
LUCRETIA OLSON is an Ecologist for the Rocky Mountain Research Station in Missoula, Montana. She earned her Ph.D. in Ecology and Evolution from the University of California Los Angeles. Her main research interests are using spatial and population ecology to better understand the distribution, stability, and habitat use of wildlife species. Her current projects include modeling distribution and habitat selection of forest carnivores (lynx and fisher) in Idaho, Colorado, and western Montana, habitat use and anthropogenic impacts on raptors in Wyoming, and impacts of wildfire on lynx in Montana. Connect with Lucretia at www.fs.fed.us/rmrs/people/lucretiaolson



JOHN SQUIRES is a Research Wildlife Biologist for the Rocky Mountain Research Station in Missoula, Montana. He earned his MS and Ph.D. in Zoology from the University of Wyoming. His current research concerns the management and conservation of Canada lynx, wolverines, and other sensitive species, including multi-scale evaluations of resource selection, forest carnivore movements and connectivity, factors affecting population viability, the effects of forest management, recreation and other human-induced impacts on species persistence, developing detection and monitoring methods for forest carnivores, and determining the effects of climate change on lynx and wolverine. Connect with John at www.fs.fed.us/rmrs/people/jsquires



ELIZABETH ROBERTS is an Ecologist for the White River National Forest in Glenwood Springs, CO. She has been a wildlife biologist and botanist for the Forest Service for 19 years. The focus of her career has been investigating the relationship between winter recreation and wildlife management in Colorado.



JAKE IVAN is a Senior Scientist in the Mammals Research Section of Colorado Parks and Wildlife in Fort Collins, Colorado. He earned an M.S. in Wildlife Biology from the University of Montana, and Ph.D. in Fish, Wildlife, and Conservation Biology from Colorado State University. His current research interests include impacts of bark beetle outbreaks on lynx, snowshoe hares and other wildlife, impacts of timber harvest on snowshoe hares, long-term population dynamics of snowshoe hares at the southern extent of their range, and large-scale monitoring of rare and elusive species.

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SCIENCE YOU CAN USE BULLETIN

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